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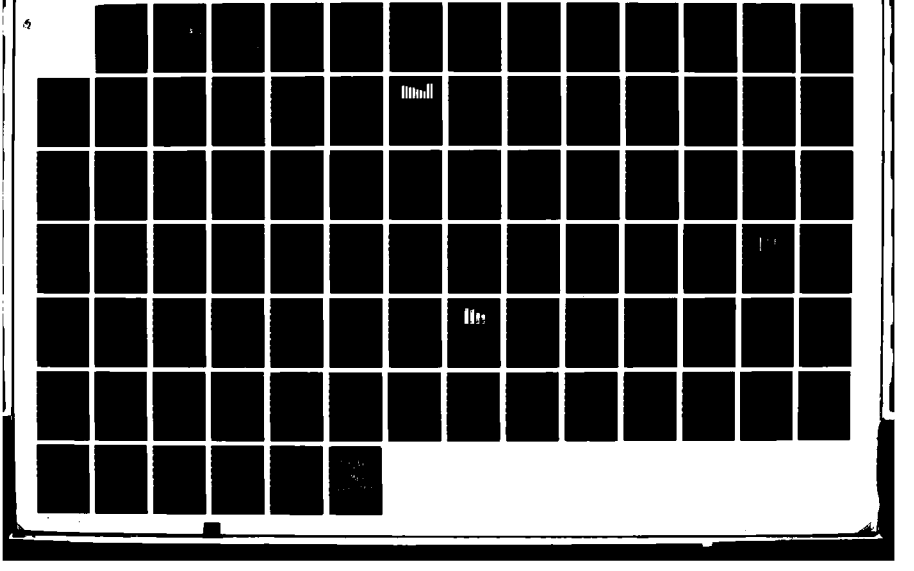

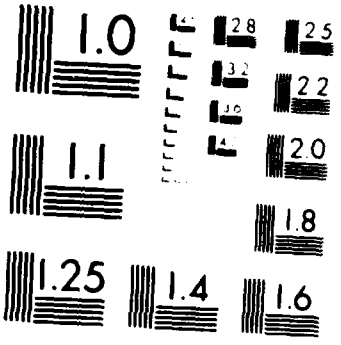

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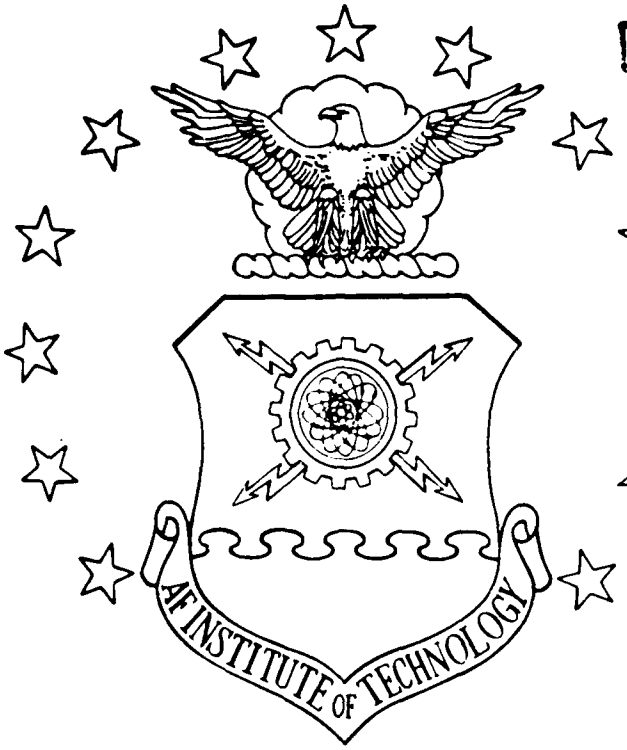

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END USER SOFTWARE DEVELOPMENT FOR TRANSPORTATION APPLICATIONS

THESIS

Keith A. Caver
First Lieutenant, USAF

AFIT/GLM/LSMA/87S-12

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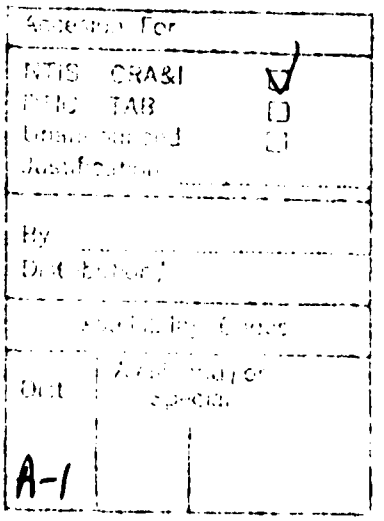

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END USER SOFTWARE DEVELOPMENT FOR TRANSPORTATION APPLICATIONS

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

Keith A. Caver, B.S.
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September 1987

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Acknowledgements

Contributions from many individuals have made this thesis effort a reality and a possibility. I am especially grateful to my thesis advisor, Major Kent N. Gourdin, for his patience, attention, and guidance throughout this research project. I also wish to thank Captain Demetrius Glass of the HQ USAF Transportation Plans and Programs Directorate for his splendid support and insight into the Air Force's end user dilemma. A word of thanks must go to the members of the Xenia Church of Christ and my family in Buffalo for their faith in me and constant prayers. Finally, I wish to thank my wonderful children Keith and Bianca, and especially my lovely wife Barbara for their understanding, comfort and love.

Keith A. Caver

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Abstract

The purpose of this study was to conduct a comprehensive analysis of the current operations and attitudes of end users in the Air Force transportation community in an attempt to identify potential problems in microcomputer operations and software development. Further, this study reviewed the current trends within private industry in the area of end user computing to explore how end users might be managed more effectively.

The study uses survey responses from a probability sample of end users assigned to CONUS transportation activities to measure current transportation end user opinion. Additionally, the survey responses measure end user involvement in software development.

This study identified three major areas of concern that the Air Force should concentrate its attention on to increase end user productivity and participation: (1) upper level management involvement in establishing transportation end user policies, (2) training, and (3) end user initiatives.

Analysis of the surveys found that the number of end users who are actively involved in software development is significantly representative of the transportation end user environment.

END USER SOFTWARE DEVELOPMENT FOR TRANSPORTATION APPLICATIONS

I. Introduction

General Issue

Information Systems are becoming increasingly essential to the ability of Air Force Transportation agencies to adapt and function efficiently in an industry greatly influenced by computers. The advent of microcomputers, and subsequent user friendly software, has provided additional benefits to the transportation industry by enabling noncomputer specialists to operate and develop information applications for their own needs (18:309-314). Although the Air Force has responded to the call for automation with major purchases of microcomputer systems, lengthy software development and acquisition lead times have limited their utilization (14; 31; 32). Most significantly, the Air Force has not capitalized on the individual efforts or talents of end user programmers as have their commercial industry counterparts (31:22-24). General Lindsey, Director of Air Force Transportation, has identified the development of automated systems as a major objective of the Transportation community for 1987 (17). General Lindsey emphasized that the Air Force must utilize any and all resources to promote the development of software for transportation purposes.

Background

The cost of typical microcomputer systems and peripheral equipment is less than ten thousand dollars. It is estimated that the cost will become even less in the years to come as technology in this area continues to increase at an exponential rate. Over ten million microcomputers are projected to be sold in 1987 in comparison to the 1.5 million that were sold in 1982 (14:3-4). However, the presence of microcomputers in the workplace does not guarantee their effective utilization. It is estimated that 20% to 36% of all microcomputers end up abandoned by users and that without appropriate management, microcomputer technology can bring as many problems for an organization as they can solve (15:313).

Martland and Waters stated, "The advent of microcomputer technology has brought an acceleration in computer adoption, much of it by personnel previously unfamiliar with computers, and for applications which were not computerized before" (18:309-310).

Since microcomputer packages are primarily aimed at non-computer experts, one of the major reasons identified for the popularity of microcomputers is the ease of learning their operations (1:316-317). In addition, user oriented software, self-explantory menus, and ease of experimentation, have all contributed to the microcomputer's success.

Although the advent of microcomputers has resulted in fundamental changes in Information Systems management, John

L. Robinson contended that, "Any new technology brings both exciting prospects and potential problems. In its haste to adopt such technologies, society often overlooks the latter in focussing on the former" (24:337). In his article, "The Dark Side of Micros", Robinson listed numerous problems associated with microcomputers in the area of software shortages and system assimilation into organizations. These two problem areas are discussed in more detail later in this study.

Military Implications. The Department of Defense (DOD) will spend an estimated $38 billion on computer software and hardware in 1990 compared to only $4.1 billon spent in 1980 (16:51). In 1983 the Air Force contracted for more than 10,000 desk-top microcomputers with the Zenith Corporation in a joint effort with the Navy. According to military officials, "this effort helped streamline the order process and made it easier for individual units to obtain microcomputers". By 1985 this number had grown to over 27,000 Zenith Z-100s with plans for the two services to purchase up to 60,000 more in coming years (31:8). The DOD currently spends $10 billion yearly on software alone, $3 billion of which is spent by the Air Force.

The Software Dilemma. The four major DOD services all face significant backlogs of software requirements for standard systems awaiting development (16:40). According to Siebert, the readiness posture of the country often suffers for want of software. He concluded the following:

> It is ironic the way military software systems have fallen behind the times. In the 5Øs and 6Øs, the government pioneered the COBOL language, standard systems, software life cycle management and data processing procurement methods. In the 8Øs they are often imprisoned by their own procedures [16:4Ø].

The $3 billion currently being spent each year on software by the Air Force acccounts for five percent of its total budget. This cost is expected to expand to ten percent of the budget by 199Ø. Not only will the amount of money spent for software development increase, the demand for software professionals will continue to outgrow their supply. The Air Force currently has 1ØØ,ØØØ,ØØØ lines of code in use, and is developing as much new software. By 199Ø the national shortfall of 8Ø,ØØØ military software professionals (both civilian and military) is projected to grow to over 1,ØØØ,ØØØ (3:46-47).

One of the major challenges the military faces is maintaining a sufficient quantity and quality of automation specialists. Of the 23,1ØØ authorizations the Air Force had in 1984 for data automation specialists, 42% were civilians (3Ø:3-5). However, the software shortage is not limited to the military. It has affected the private sector just as much, which has, in turn, caused a greater problem for the DOD. Because of their increased need for software engineers, private industry is offering "top dollar" to lure military officers and DOD civilians away from an already depleted force. In many cases, commercial industry offers two to three times the salaries provided by the military for

software professionals (3:48).

To combat the software shortage problem, project Bold Stroke, a software management action plan, was developed in 1985 (29:29). This program detailed objectives from making managers more aware of the significance of the software problem to planning for training future software professionals to fill an ever widening void. In implementing Bold Stroke, General John L. Piotrowski, the USAF Vice Chief of Staff, stressed that unless the Air Force comes to grips with the critical issue of software, "we run the risk of blunting our critical edge in computer-based technology through inept exploitation as well as squandering scarce computer resources as the result of ill-informed leadership and direction" (3:47).

Specific Problem

While the Air Force has recognized that automated systems for transportation applications are extremely important to keeping the military abreast of commercial industry advancements, little has been done to enhance and encourage the abilities of military end users in software development. This study is a comprehensive analysis of the current operations and attitudes of end users in the Air Force transportation community which identifies potential problems in microcomputer operations and software development. Further, this study reviews the current trends within private industry in the area of end user computing to explore how end users may be managed more effectively.

Information obtained from the study was provided to the HQ USAF Plans and Programs Directorate in an effort to improve the Air Force end user participation in software development transportation applications.

Investigative Questions

The following investigative questions were developed to study the problems posed in the previous paragraphs.

1. Are the number of transportation end users that are currently involved in software development significantly representative of the transportation end user population?

2. What type of end user software has been developed?

3. What programs has the Air Force made available to assist end users in their software development efforts?

4. What hardware/software is available to assist end users in their programming efforts?

5. What factors significantly contribute/limit the participation of end users in software development?

6. How does prior computer knowledge or experience compare with end user participation in software development?

Summary

This chapter has introduced and discussed the general problem under study. Additionally, an in-depth background was presented to provide further insight into the nature of the general problem and specific problems. Finally, several investigative questions were presented which will be considered in the research.

II. Literature Review

Introduction

This literature review will address several topics opening with a general definition and discussion of end users, their different characteristics, and end user computing. The next section outlines the benefits and detriments of end user computing. The following subject outlines the evolutionary progression of automation in organizations. Next, current approaches to managing end user computing are discussed in detail. The final discussion in this chapter concerns the Air Force perspective of end user computing.

End Users, the New Computing Resource

End users are defined as individuals who input, manipulate, or retrieve information using computer applications or tools (4:530). Quite often, end users are assigned to primary responsibilities other than those that require interaction with information systems. Additionally, the degree of frequency of use of computer systems, and the knowledge level may vary between end users (4:530-531). A recent study conducted by Denis M. Lee revealed some interesting aspects of end users (15:315-320). Lee's findings suggested that while most microcomputer users have limited computer knowledge, there is a strong positive correlation between those users with computer backgrounds and the frequency of microcomputer usage and diversity of applications. Additionally, the study revealed that end

TYPE OF USER	DESCRIPTION
Nonprogramming end user	Accesses the system through a highly structured interface. Does not program applications.
Command level end user	Some application programming using high-level commands.
End User Programmer	More sophisticated user. Knows and uses programming language for solving problems specific to own job.
Functional Support Person	Sophisticated user. Writes programs and uses other facilities in support of users in a functional area.
End User computer support person	A centralized information system specialist whose function is to utilize facilities to support the needs of end users.
Data Processing Programmer	Employs end user facilities as an alternative to regular data processing development tools.

Figure 1. End User Classifications (4:422)

users spent the greatest amount of time using spreadsheet applications, word processing packages, and personal programming, in that order (15:316).

End User Classifications. Rockert and Flannery classified end users into six basic catogories: non-programming end users, command-level end users, programming-level end users, functional-support personnel, end user computer support personnel, and data-processing programmers (25:776-784). Figure 1 identifies each type of end user with a brief description of the associated characteristics and functions (4:422). Although their study did not include microcomputer users, the Rockert and Flannery framework is generally accepted by information system professionals as being representative of microcomputer end users.

Figure 2 depicts the results of Lee's study (15:315) on the usage pattern of microcomputer professional workers and

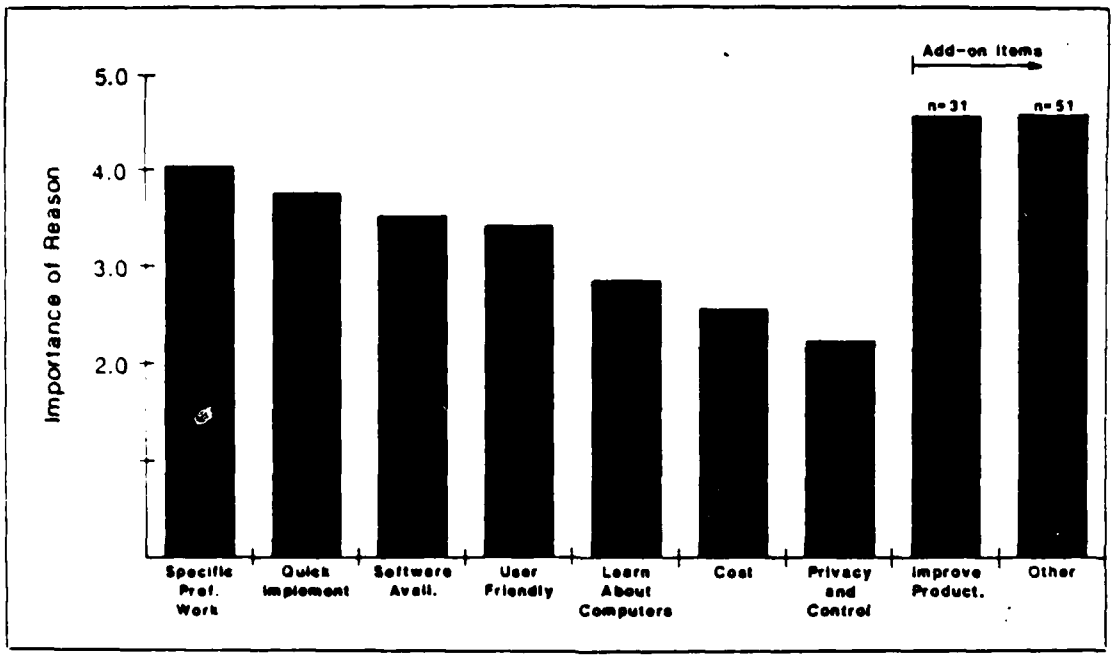

Figure 2. Reasons for Using Microcomputers (13:315)

managers. Respondents identified that the most important factors for using microcomputers were professional work, quick implementation, software availability, and user friendliness. Ten percent of those queried indicated that "to improve productivity" was a major factor. Additionally, 16% identified other reasons that related to specific computer applications. These final two responses further emphasized that implementation of professional work was the primary reason for using microcomputers (15:314-315).

End User Computing. As Information Systems departments struggle to keep up with the ever increasing demand for software requirements, it is becoming more apparent to management that this department alone cannot meet users' computing demands (16:337). Until recently there have been two major sources of software for microcomputer appli-

cations: those which have been developed by technical specialists within the information systems department, and those that are purchased commercially. However, there is a third source available for viable microcomputer application within most organizations. If they have access to a microcomputer, the same individuals who depend on information systems resources to provide assistance for computing requirements, can and should be viewed as possible sources for many of these same applications (26:69; 31:22).

End user computing is defined as the creative use of computers by other than data processing experts (16:338), and is one of the most significant developments in information management field to take place in the last decade. End user programmers may be highly trained professionals in their own area of expertise who, by virtue of their prior experience or personal initiative, have ventured into the programming arena to develop specific applications for operational tasks (13:3).

Growth of End User Computing. The rate of end user growth and change has been phenomenal. The Xerox corporation, for example, estimated that by 1991 75% of their company's computer resources will be dedicated to end user computing compared to just 25% in 1981 (13:3). Other studies validate this estimation and further indicate that end user computing is growing at a rate between 50 and 90% per year (26:69). It is estimated that by 1990 four out of five administrative and professional workers will be using

microcomputers to support their work or personal activities (2:35).

The growth of end user computing has not gone unnoticed by management. A recent survey of leading MIS executives, consultants, and researchers revealed that end user computing was second only to MIS planning in terms of importance (16:337).

Benefits of End User Computing

Gerrity and Rockart emphasized that the benefits of end user computing are not readily justifiable in terms of return on investment of traditional information systems. Rather, individual efficiency and effectiveness are often the initial payoffs. Other advantages of end user computing recognized by private industry are the users accelerated learning about his job, the discovery of innovative approaches to tasks that can change the nature of the job, and the opportunities and capabilities associated with the technology itself. Another managerial benefit of end user computing applies to organizations comprised of people further down the end user "learning curve". These institutions possess cadres of managers at all levels who are better equipped to gather, use, and disseminate good management information for improved organizational effectiveness (8:26). Operational benefits of end user computing include shorter lead times on development request, and more control over system development by users. It also fulfills a need for end users who desire to know more about

the system, and provides users with greater flexibility over their applications. One final benefit attributed to end user computing is that it can significantly reduce software development costs (16:338).

Problems of End User Computing

One of the major problems noted by end users is the nature of the training they receive. Evidence suggest that the training users receive is limited in scope, and extremely technical. The purpose of the training appeared to be to impart the basic skills necessary for using or operating packaged software (10:182). The respondents to a 1986 study conducted by Denis Lee revealed that the greatest barrier they face in computing was a lack of time and user assistance (15:324). Two other common problems noted by separate studies were a lack of standardization of software and equipment (31:22; 10), and lack of top level management direction (13:3-4; 8:27).

Evolution of Computer Systems

Many studies have been conducted to investigate the growth of microcomputers in organizations. One of the most highly regarded of these is the Nolan Stage Model developed in 1974 by Cyrus F. Gibson and Richard L. Nolan (9:72-80). They proposed that there are four distinct stages in the growth of all information system activities, each with its distinctive applications, rewards, and problems. Although the Nolan model was designed to represent the evolution of information systems, the growth of the end user population

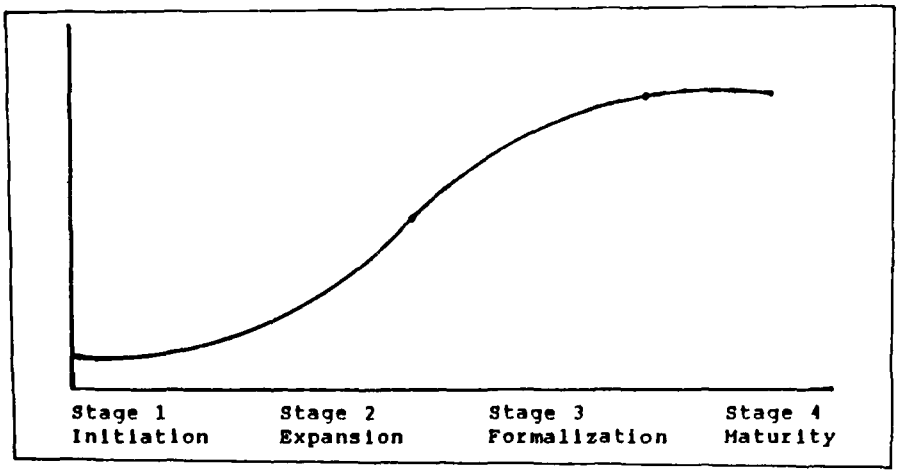

Figure 3. Nolan Stage Model (9:78)

may be explained by comparing it to this model of the diffusion of innovation in organizations (13:5; 4:451). Henderson and Treacy stated that the classic S-shaped curve typified by the Nolan Model in presented in Figure 3, is similar to the technological learning curve of end user computing. The S-shaped curve characterizes "the acceptance of any innovation over time as starting slowly, increasing rapidly as the innovation gains momentum, and trailing off gradually as saturation levels are reached" (13:5). The four stages of the Nolan model were later expanded to six; however, the relevance and significance of the model can be explained in its original form (4:421-422).

Stage 1: Initiation. This stage is characterized by the purchase of computers to perform time consuming tasks formerly done manually. There are a small number of users to meet basic organizational requirements, and computer operations are decentralized with the computer system being

located in the area where it will receive the most use. At this stage long-term implications are rarely considered by management, and there is little strategic planning for other impacts of the computer on personnel, or the organization (4:450-452; 9:77-80; 7:11-13; 13:10-11).

Stage 2: Expansion. The expansion stage is distinguished by a rapid and uncontrolled growth in the use and acquisition of computer systems. There is little control imposed by management in an effort to encourage greater use of systems. Eventually, end user enthusiasm and creativity evolve into user developed applications programs. As a result of the proliferation of new applications and requirements by users, and the lack of planning and control by management, costs rise at a staggering rate (4:450-452; 13:10-11; 9:80-83; 7:13-14).

Stage 3: Formalization. As the organization moves into the Formalization stage, formal planning, standardization, and integration increase in an effort to curb the chaotic situation created in the Expansion stage. Centralization and organizational controls typify the formalization period. In some cases, however, over controlling during this phase can prove to be detrimental to the organization in that it may stifle the creativity and production of end users (4:450-452; 13:11-12; 9:83-86; 7:15-16).

Stage 4: Maturity. In the Maturity stage of development, organizations experience an integration of applications. Controls are adjusted and end user computing

objectives are brought in line with corporate policies. At this stage management has finally gained control of the budget and departmental personnel operate under clear guidance (4:450-452; 13:12; 9:86-88; 7:16-17).

Although researchers recognize that most companies are still in the "initiation" or early "expansion" stages of the growth curve, they indicate that the most adverse effects of the "formalization" stage may follow unless significant attention is paid to managing end user computing (2:35). By examining the Nolan model, many of the pitfalls experienced in previous automation efforts may be identified and subsequently minimized or avoided entirely by managers in assimilating end user computing into organizations (7:17). Henderson and Treacy suggested management take action in the early Initiation stage to direct the smooth and controlled transition into the Expansion stage and ultimately into the Mature stage (13:13). They further emphasized that skipping any phase of the Nolan model may result in increased organizational conflict and ineffectiveness.

Approaches to Managing End Using Computing

The Henderson and Treacy study suggested there are four fundamental issues that must be considered in the area of managing end user computing: the support infrastructure, the technological infrastructure, the data infrastructure, and evaluation/ justification and planning (13:3-4). First, they suggested that since each type of end user requires different education and support, it is difficult to design

an organizational infrastructure to support end user computing. Second, the technological infrastructure involves managerial decisions about the appropriate hardware, software, and other peripheral equipment required to support operations. Third, issues concerning data standards, security requirements, and subject data bases compose the data infrastructure framework. Finally, Henderson and Treacy stated that in order for management to realize the organizational improvements as a result of end user computing, it must plan and maintain the financial and organizational impact of system investments (13:3-4).

Three Common Approaches. Gerrity and Rockart indicated that there are three common approaches that management can take to control end user computing: the monopolist approach, the laissez-faire approach, and the information center approach (8:27-30).

Monopolist Approach. This approach is characterized by total managerial control over all end user computing. Usually this control limits computing initiatives severely. New purchases of microcomputers are scrutinized carefully, and on-hand systems are restricted from access to organizational data bases. Management operates from a perspective that all applications systems should be developed by a professional to ensure strong control over the privacy and security of data, and over financial considerations as well. The Monopolist approach is breaking down in many organizations for numerous reasons.

First, there are not enough programmers to develop all end user required systems. Second, with the declining costs of computer hardware, it is apparent that management's focus on the control of hardware cost is irrelevant. Third, the documentation and controls required for developing large paperwork processing systems are not normally required for other than one-time use by the developers. And finally, many end users realize that they can develop many systems more quickly and cheaply for specific applications, than waiting for request to be filled through traditional programming channels (8:28).

Laissez-Faire Approach. This approach is basically the opposite of the Monopolist approach. Users are allowed to buy and develop whatever their budgets will allow. There is no central organizational strategy for managing end user computing, and the key idea is for each user to make creative, effective use of tools. In addition to financial considerations, this approach has other problems and implications for management. There are no provisions for changing user developed support systems into formal standardized programs. With the large diversity of hardware and software in the market, this approach does not present an effective method of scrutinizing purchases to preclude duplication of effort by users and uncontrolled expenditures. Finally, the standardization of equipment and transferability of information suffer as a result of the lack of strategic planning (8:28-29).

Information Center Approach. This approach is an initial attempt to provide a focused managerial approach to end user computing. The Information Center (IC) is a centrally located group of people to whom users can refer to for guidance and support concerning the selection and use of information system equipment. Members of the IC not only provide informational assistance, but are available to train personnel on specific hardware and software requirements. Although the IC is a much improved framework than the other two approaches, it is not without its problems. As usually structured, the IC is a centrally located organization while users require local support. Even though members of the IC possess technical expertise, they are usually lacking in the area of functional applications knowledge. In most cases, the IC department doesn't involve user interaction in its development processes or plans, and is primarily reactive to user requirements as opposed to being proactive. Finally, the IC reflects a managerial solution in terms of structure without an established strategy. However, many organizations normally ignore the critical aspect of outlining a specific strategy for technological advances and therefore render the IC less valuable (8:30).

A New Approach: Managed Free Economy. Gerrity and Rockart suggested what is needed is a proactive and strategic approach to managing end user computing. Users must have the freedom to create, define, and develop individual applications. However, there must be some

central authority to consult with users concerning the feasibility of applications, and to support users when information systems expertise is required. There is a need for control. A central authority must develop policies to limit and identify the types and number of microcomputers to use. In doing this, it is easier to establish a training program to meet the needs of the individual users. There are five critical attributes to the Managed Free Economy that are lacking from the other models. First, there is a stated end user strategy that provides the organizational direction and key elements of implementation to personnel. Second, there is a working partnership between the users and the information system technicians. Both the strategy and all programs that grow out of it must reflect the user needs. The third aspect provides active targeting of critical end user systems and applications by management as opposed to relying on end users to identify long-range benefits or those that span multiple departments or individuals. End users often do not possess the foresight or expertise to formulate or envision potential system possibilities. Strategic minded managers benefit by being involved in the early stages of system development. Next, by providing an integrated end user support organization, management can maintain the confidence and enthusiasm levels of end users. End users are busy people who require extensive support. Therefore, support must be localized with the support personnel initiatives focused on teaching

and helping, but not doing. Finally, the Managed Free Economy approach emphasizes the importance of education throughout the organization. Gerrity and Rockart stressed that "a well-thought-out educational program, adapted to the needs of each type of "student," is absolutely necessary to allow an organization to make effective use of the technology" (8:33).

An Organized Approach. "An effective approach to managing end user computing", suggested Letheiser and Wetherbe, "achieves both facilitation and coordination" (16:340). They indicated that service support levels provide both these qualities by defining computing responsibilities and providing a framework which allows a support services operation to be designed. Additionally, the Organized Approach allows end users as much control as possible over their own computing (16:340).

> Service support levels are formal divisions of computing responsibility between end users and the MIS department. These divisions are based on a small set of critical decisions that are made by end user management. The way managers make these decisions commits them to accept certain responsibilities and allows them to turn over others to the MIS department...If the MIS department is to meet its objectivs of coordinating and facilitating end user computing it must develop and deliver support services to meet needs [14:340].

There are four advantages to this approach of managing end user computing. First, by clearly specifying departmental responsibilities, it reduces uncertainty of task assignment. It also provides a structure for MIS support of end user requirements by a common pool of technicians.

Third, End users have an incentive to improve their computing practices and therein reduce the computing risks to the firms. Finally, this approach provides a way for the MIS department to coordinate and manage end user computing. "Some end-user computing will remain outside of this coordination effort, but those activities are recognized to be the responsibility of the end user managers" (16:340).

Support services offered by the MIS department should include, but are not limited to, general consulting, product support, hotline/help desk, technical support, quality assurance, and end user training. General consulting service is responsible for advising, development activities and primary focuses on problem definition and analysis. To assist users with development, documentation, resource, listing, and maintenance, product support personnel should be available. One of the key aspects of services support is the hotline/help desk designed to aid end users who have short, immediate problems. The hotline service features a phone number that end users call to get answers to specific questions. For more detailed information users can go to the desk and have a more lengthy discussion with the technician. Technical support provides backup, some maintenance, data transfer, and recovery activities that require specialized expertise. These personnel are usually contacted indirectly via the hotline. Quality assurance is concerned with compatibility, development, and documentation activities. End user training ranges from establishing a

general awareness about end user computing to explaining specific details of the operation. This may involve conducting classes or demonstrations, developing on-line interactive training programs, providing newsletters, or establishing user groups to promote end user sharing of talents and information (16:346-347).

End User Computing in the Air Force

Like its private industry counterpart, the Air Force has three primary sources of microcomputer software. The first source is the Air Force's Standard Information Systems Center (SISC), located at Gunter AFS, Alabama. The second source is general-purpose commercial software developed by private industry. The third source is end user developed software (31:22). As in the private sector, end user computing provides the Air Force with many benefits.

> End user development side steps many of the problems associated with traditional Air Force software development methods. Compromises between requirements and the cost (time and effort) of software development can be made by the person who will have to live the finished program [31:22].

Two potential problems that the Air Force must consider in the area of end user computing are documentation and standardization (31:22-23). Captain James Van Scotter stressed that due to the high turnover ratio of Air Force personnel and the very nature of the infrastructure itself, documentation requirements are a must. Without some form of documentation for end user developed systems, providing effective maintenance support would be nearly impossible.

Likewise, the lack of standardization and control of end user developed applications can only lead to duplication of effort among users (31:24). Similar research has been conducted by other DOD service components and the results reflect the same major concerns. Although the benefits of end user computing may have tremendous impact on the organization, without some form of centralized control and standardization, operational inefficiency is inevitable and end user effectiveness will be hampered (14; 7; 28).

> While users can certainly assume more responsibility for their applications programming and maintenance, policy development and strategic planning still require a centralized automated systems support staff. With out this type of centralized control, the results would be duplication, lack of standardization, and inefficiency [30:16].

While the Air Force has focused the majority of its attention on obtaining microcomputer hardware and software and managing end user computing, little emphasis has been placed on the maintenance and support of end user developed software. The maintenance requirements for end user software are rapidly becoming as important as the development of the end user program itself. Experts project that by the year 1990, 50% of all Air Force software development will be accomplished by end user programmers, and these same users will be responsible for locally maintaining many of their operational programs (31:22, 32:30).

End User Training. One of the major limiting factors that experts have identified for end users is in the area of microcomputer training. As in the civilian sector, the Air

Force must also deal with this very real problem of ensuring that end users receive adequate training to be able to perform tasks associated with the responsibilities of their jobs. Additionally, if the Air Force wants to take full advantage of the end user as a viable resource for software development, there must be some avenue available for individuals to receive adequate training in the numerous microcomputer application programs available.

To meet the training needs of the numerous end users in the Air Force community, the Air Force has established a Small Computer Training branch which operates out of Keesler Air Force Base, Mississippi. The training offered by this organization ranges from systems orientation for operators, to programming, systems analysis, and site management. The courses that are provided result in Community College of the Air Force (CCAF) credit for each student who successfully completes the program. The Small Computer Training branch offers two types of courses: those conducted in-house (at Keesler), and those conducted at the requesting organization's base. Units desiring to have a training team come to their installation to conduct a training program are asked to have at least 36 students who will be divided up into two groups. Additionally, the units are responsible for providing one computer for every two students. Each course takes either three to five days depending upon the desired program, and the courses will run consecutively. The basic outline of every program is to provide the users

with instructions in wordprocessing, data base, and spreadsheet applications. Units can request training for any one of the programs by submitting a Air Force Form 403, Request for Specialized Training, through their individual training representative to the Small Computer Training Branch (20).

SCALE. The Small Computer Applications for Logistics and Engineering (SCALE) project is an attempt by the Air Force to help mitigate the potential problem of redundancy and duplication of effort in the area of end user software development (31:24). SCALE was designed by the Air Force Logistics Management Center (AFLMC) to provide a central repository for information concerning microcomputer programs (22:ii). SCALE offers two benefits to end users. First, end users can have access to a software data base which contains information about functional applications programs. The information in the data base includes the title of the program, the specific area for which can be used, the memory required to operate the program, the hardware/software required, and a point of contact who can provide the individual with a copy of the program if desired. The second benefit offered by the SCALE program is that it allows the end user to enter their specific software program into the system by means of a modem interface. Instructions for the various functions and requirements for the SCALE program can be made available to individual end users by contacting the AFLMC SCALE office at Gunter AFB, Alabama.

TSIP. The Transportation Systems Integration Panel (TSIP) is an initiative designed by the Air Force to provide end users with the necessary management and direction to refine non-standardized, interim software computer programs. According to Captain Demetrius Glass of the Transportation Plans and Programs Directorate, HQ USAF:

> TSIP would develop, manage and operate non-standard systems needed within transportation. Once the programs have been developed, the TSIP would support their products with the help of the local ISSO (Information Systems Services Office) for maintenance and modification. The TSIP would also provide transporters with the tools and knowledge to access and analyze computerized information directly [12:1]

The TSIP is designed to act as a resource center complete with specialist and reference material available to assist transportation end users. Additionally, the TSIP will establish end user computing policies, expand technology to meet the rapidly changing end user environment, and provide guidance to top level management (12:2). A copy of the proposed charter for the Transportation Systems Integration Panel has been included in this study and is found in Appendix E.

Summary

End user computing is rapidly increasing in both the civilian and military communities. This chapter began by defining end user computing and the numerous classifications in which end users fall. Along with the rapid growth of this new computing resource has come both benefits and detriments. Numerous studies have been prompted which

attempt to explain the inception of the end user programmer into the organization. Additionally, a number of management theories have been developed that are specifically aimed towards end user computing. This chapter concluded by outlining the specific impact and implications that end user computing has created for the Air Force.

Even with its advantages and disadvantages, end user computing is a productive and effective addition to any organization. The remainder of this research effort will be directed towards investigating the Air Force's Transportation end user environment.

III. Methodology

Introduction

This chapter describes the methodolgy used to collect the required data to answer the research questions generated in Chapter I. A survey was thought to provide a more objective and quantifiable measure of the user's involvement and perception of end user computing than data derived from an interview, a review of project files, or other approaches. Additionally, the population, sample, and specific statistical tests that were used for this study will be outlined.

Survey Instrument

The survey approach was used to collect data for this study. A questionnaire was developed and administered to Transportation squadron end users to measure their understanding of, and involvement in, microcomputer operations and software development. In addition to open-ended questions designed to extract specific information from individual users, multiple choice questions were included in the survey to determine a number of other factors concerning end user operations. Areas to be measured included degree of involvement in, and knowledge of, software development, limiting factors in software development, and sources of local assistance for computer operations.

Population and Sampling

The sampled population was the set of all Continental United States (CONUS) bases whose major transportation

squadron or agency possess at least one microcomputer. This information was obtained from the Air Force Logistics Management Center (AFLMC) Transportation Staff offices located at Gunter AFS, Alabama.

The appropriate sample size required in order to achieve a 95% confidence/reliability level was generated using the following formula (11:1-2).

$$n = \frac{N(z^2) * p(1-p)}{(N-1)(d^2) + (z^2) * p(1-p)}$$

where: n = sample size

N = population size

p = maximum sample size factor (.50)

d = desired tolerance (.05)

z = factor of assurance (1.96) for 95% confidence level

A random number generator was used to identify transportation units to be surveyed from the population (19:223-224).

Data Collection Plan

In addition to surveying Transportation end users, members of the HQ USAF Transportation Plans and Programs staff and the AFLMC staff were interviewed to gather specific information on transportation automation programs. Further, these staff personnel were asked to provide information and guidance that outlined Air Force efforts to identify, centralize, evaluate, and enhance end user computing. Information concerning current available training programs and trends was obtained by contacting the

Information Systems Advanced Training Division at Keesler Air Force Base, Mississippi. After validation, the survey instrument was sent to randomly generated sample Transportation units with complete instructions and a 5 day suspense.

Statistical Tests

To examine the participation level of end users in software development, binomial random variables were used. Since respondents were asked whether or not they were involved in software development, there were only two possible responses. This characterizes the binomial random variable in that there are only two possible outcomes. However, a confidence level and z-test were computed to examine the significance of the number of end users who are actively participating in software development (19:313-315). Survey responses were read using an optical scan reader and the data was input into Air Force Institute of Technology's Acedemic Support Computer (ASC). The Statistical Package for the Social Sciences (SPSS) programming procedures were used to perform statistical analysis on the data. SPSS was chosen because it provide all the necessary abilities for managing, analyzing, and displaying data in a simple and logical format (21:4-6).

Analysis and Justification of Methodology

The survey approach was chosen primarily because there was no data readily available on the end user involvement in software development. Although cost and time constraints

make the survey method an unattrative alternative, it is not without its benefits. First, a large sample can be collected by a single person. Second, it is relatively expedient (if respondents reply in a timely manner). And finally, the respondent has no time constraints in which to force answers which have not been considered completely and is apt to answer more freely (5:182-187).

Descriptive statistics were used to describe elements of the Transportation end user community both graphically and numerically. Frequency analysis of survey data was used to address research questions concerning the current operations of end users. Additionally, descriptive statistics provide an avenue for explaining qualitative data in a meaningful and succinct form.

Inferential statistics were used to investigate the significance of end user programming participation in the Transportation community. Additionally, Inferential statistics provided the benefit of allowing certain conclusions about populations based on significant sample findings. A randomly generated sample was used because it provided every member of the population with an equal chance of being selected. Further, random samples strengthened the external validity the study and fulfilled the assumptions required for Inferential statistics (19:6).

Limitations

The most significant problem anticipated was that of ensuring that organizational end users throughout the unit

completed the surveys and returned them in a timely manner. Although the surveys were sent to the squadron Plans and Programs branches, microcomputers are distributed throughout the entire Transportation squadron in most cases. The Plans and Programs branch is designed to act as the unit's data automation monitor and central point of contact for computer inquiries. Thus, individual unit Plans and Programs personnel were instructed to disseminate the surveys to specific end users throughout the squadron.

IV. Findings and Analysis

Introduction

Chapter II explored the nature of end user computing, the numerous methods by which it can be measured effectively, and the impact of end user computing on the Air Force environment. Based on this information, Chapter III outlined the procedures that were used to collect data for analysis and evaluation concerning end user computing. This chapter captures the essence of the research effort by analyzing the data collected from the survey respondents and answering the investigative questions posed in Chapter I.

Survey Description

The survey described in Chapter II attempted to establish the current usage patterns and attitudes of end users in the transportation environment. The categories selected as possible responses for each question were designed to provide each respondent with a wide variety from which to select. Although the responses did not capture a true ratio, ordinal, or nominal scale, they did allow the drawing of conclusions based on the frequency of responses. The following paragraphs briefly describe each question posed by the survey. A copy of the survey is contained in Appendix A.

Question 1 asked the end users to identify the type and model of microcomputer(s) assigned to their individual sections. This question was designed to identify the various types of microcomputers that are being used in the

transportation environment.

Questions 2-4 asked the respondent to identify how long their section had possessed its microcomputer, how many months they had personnally operated the equipment, and what type of peripheral devices they had assigned. Once again, this information was requested in order to examine and compare the frequency of responses.

Questions 5-7 instructed the respondents to list the types of software packages that their sections possessed, the types of software packages that they personally know how to operate, and the types of software applications that the use in the performance of their jobs. This purpose of this series of questions was to determine if the pattern between the availability, knowledge, and usage of software application programs was relatively consistent in the end user population.

Questions 8-11 asked the users to indicate if they had received any Air Force sponsored microcomputer training or if their individual units had any programs designed to assist them in their computing efforts. These questions were designed to answer investigative question 3 identified in Chapter I.

Questions 12-13 directed the respondents to identify the amount of computer experience they possessed prior to their current responsibilities, and to indicate the highest level of formal computer education they possessed. These two questions were formulated to answer investigative

question 6 listed in Chapter I.

Questions 14-20 asked the end user to identify any programs they had created or adapted for particular applications. Additionally, this series of questions queried respondents about their knowledge of, and participation in, activities aimed at submitting self-developed software for possible standardization by the Air Force. The information derived from responses to these questions was used to answer investigative questions 1, 2, and 5 identified in Chapter I.

Question 21-25 prompted the end users to respond to general questions about the usefulness of microcomputers and end user developed software. The intent of these questions was to provide some descriptive information on the general attitudes of end user respondents in these subject areas.

Question 26 instructed the respondent to indicate sources of assistance they had consulted for solving software problems. Once again, this question was designed to determine if there was a general consensus of the sample.

Question 27 asked the survey recipients to indicate whether or not they owned a microcomputer. This question was designed to compare the number of microcomputer owners with the number of individuals who are involved in software development.

Survey Response Analysis

Using the formula presented in Chapter III for determining an appropriate sample size, a randomly selected

group of 66 transportation agencies was selected to be surveyed. However, based on an assumed 60% response rate, the sample size was reconstructed to include 14 additional units and the total was increased to 80 bases. Each base was mailed a package containing five surveys. Therefore, the total number of surveys distributed was 400. Of the 400 surveys mailed, 212 were returned, representing slightly more than a 50% return rate. However, of the 80 bases queried, 61 bases had a least one end user respond, which resulted in a 77% base response rate. The following paragraphs represent the findings of the surveys in relation to the six investigative questions posed in Chapter I.

Investigative Question 1: The first investigative question asked if the number of transportation end users who were involved in software development was significantly representative of the transportation end user population. Survey question 14 was designed to provide the data for answering this question. The objective of survey question 14 was to estimate the proportion of all end users who are involved in software development. This study revealed that out of 212 respondents, 126 end users use some form of applications program to develop unique programs to assist them in the performance of their jobs. This number represents the compliment of all end users who provided a negative response to question 14, indicating that they had not developed any software programs. Furthermore, this number is a binomial random variable as defined in Chapter

II. The probability, " $\hat{p}$ ", that a transportation end user is involved in software development efforts is the parameter to be estimated. The probability " $\hat{p}$ " is estimated by calculating:

$$\hat{p} = x / n$$

where

$\hat{p}$ = probability of success in the binomial experiment

x = number of successes in the sample

n = number of trials

Since 126 of the 212 respondents were found to be actively participating in software development, the estimated proportion of all transportation end users who are involved in developing software applications was found by the following calculation:

$$\hat{p} = 126 / 212 = .594$$

Since the Central Limit Theorem states that the relative frequency distribution of the sample mean for any population is approximately normal for sufficiently large samples, a confidence interval and test hypothesis about " p " is completely analogous to that used for large-sample inferences about the mean of a normal population (19:313-314). A Large-Sample Confidence Interval for " p " was conducted using a 95% significance level to determine the proportion of all transportation end users who are involved in software development efforts. The following formula was used to determine the true percentage of all end users who are actively were involved in software

development. That is, in repeated construction of confidence intervals, approximately 95% of all samples would produce confidence intervals that enclose " p " (19:315):

$$p \pm z_{\alpha/2} \sqrt{pq/n}$$

where

$p = x / n$

$q = 1 - p$

and where

p = probability of success in the binomial experiment

q = probability of failure in the binomial experiment

x = success in a single trial

n = number of identical trials

z = established z-score based on pre-determined alpha level

In calculating a large-sample confidence interval (C.I.), " $\hat{p}$ " can be used to approximate " p " (17:314). Therefore, the formula can be computed by substituting the appropriate values as follows:

$$C.I. = \hat{p} \pm 1.96 \sqrt{\hat{p}\,\hat{q}/212}$$

or

$$C.I. = \hat{p} \pm 1.96 \sqrt{\hat{p}\,\hat{q}\,/212}$$

$$C.I. = .594 \pm 1.96 \sqrt{(.594)(.406)/212}$$

$$C.I. = .594 \pm .066 = (.528, .660)$$

Therefore, the Air Force can be 95% confident that the interval between 52.8% and 66% of all transportation end users contains the true percentage of individuals who are

involved in software development.

In addition to the confidence interval computed above, a Two-Tailed hypothesis test was conducted about " p " to see if there was sufficient evidence to indicate that the probability of transportation end users who participate in software development efforts was not 60% (19:315). The basic hypothesis was:

$$H_o: p = p_o$$

$$H_a: p \neq p_o$$

where

$p = p$

$p_o = .60$

The test statistic used was:

$$z_{crit} = p - p_o / \sigma_p$$

where

$$\sigma_p = [p_o(1-p_o)]/n \quad \text{(if } H_o \text{ is true)}$$

The rejection region for a 95% significance level was established as:

$$z_{\alpha/2} < -1.96 \text{ or } z_{\alpha/2} > 1.96$$

A test of the null hypothesis (H_o) against the alternate hypothesis (H_a) at an established 95% significance level revealed the following:

$$z_{crit} = \sqrt{p - .60/\sigma_p} = \sqrt{(126/212) - .60/.033} = -.182$$

Since the calculated value of " z " does not fall into the rejection region, there is insufficient evidence to indicate that the percentage of all end users in the transportation end user population who actively participate in software

Table 4.1

Frequency Table for Survey Question 14

Response	Frequency	Percentage of Respondents
None	87	47.3%
Wordprocessing	95	51.7%
Data Base	75	40.8%
Spreadsheet	43	23.8%
Graphics	26	14.2%
Communications	6	3.3%
Disk MX/Utilities	22	12.0%
Other	11	6.0%

development is not 60%. Basically, at a 95% confidence level, the null hypothesis is not rejected.

Investigative question 2: This question asked what type of software has been developed by transportation end users. Survey questions 14 and 15 were related to this investigative question. Table 4.1 identifies the types of application programs that end users indicated that they manipulated to develop their specific software programs. By far, the largest two types of programs used were word processing and data base applications. Survey question 15 was an open ended question which directed the respondents to briefly describe what specific application their program was used for. A summary of the responses to this question is included in Appendix B.

Investigative Question 3: This question asked what programs or initiatives had the Air Force made available to assist end users in their software development efforts. In addition to the initiatives identified in Chapter II (i.e. SCALE, TSIP, microcomputer training) survey questions 8-11, and survey question 22 addressed this issue. The individual responses provided further information into this area and are summarized below.

Only 17% of the respondents indicated that their squadron offered a training program for users to learn how to use available software. Simarlarly, only 18% of the end users said that their individual organizations offered a training program for new system operators. However, when asked if they had attended any Air Force sponsored training outside their individual units, a slightly higher number of end users (27%) had a positive response. Additionally, 32% of the respondents indicated that their squadrons had a published set of Operational Instructions (O.I.'s) for microcomputer operators.

When asked if their individual bases sponsored a microcomputer users group for their particular system, nearly 50% of the respondents indicated that they did not know. Only 6% of the end users stated that they actively participated in their particular bases' users group, while almost 20% indicated that they did not participate at all. The remaining 29% of the respondents stated that their bases

Table 4.2

Frequency Table for Survey Question 4

Response	Frequency	Percentage of Respondents
Daisey-Wheel Printer	41	19.3%
Dot-Matrix Printer	154	72.6%
Graphic Plotter	19	9.0%
Modem	81	38.2%
Disk Drive	108	50.9%
Other	27	12.7%

did not sponsor a users group for their particular microcomputer system.

Investigative Question 4: The fourth investigative question concerned the availability of software and hardware to assist the end user in their programming efforts. Survey questions 4-7, and 26 all were designed to address this issue by asking the end users about assigned software, peripheral equipment, and sources of assistance for trouble-shooting or other information. Additionally, this series of questions also queried the respondents about their knowledge of assigned software and their use of these application programs in the performance of their responsibilities.

Table 4.2 above summarizes the responses to survey question 4 indicating what peripheral equipment transportation end users have available. The largest common item is by far the dot-matrix printer which is possessed by

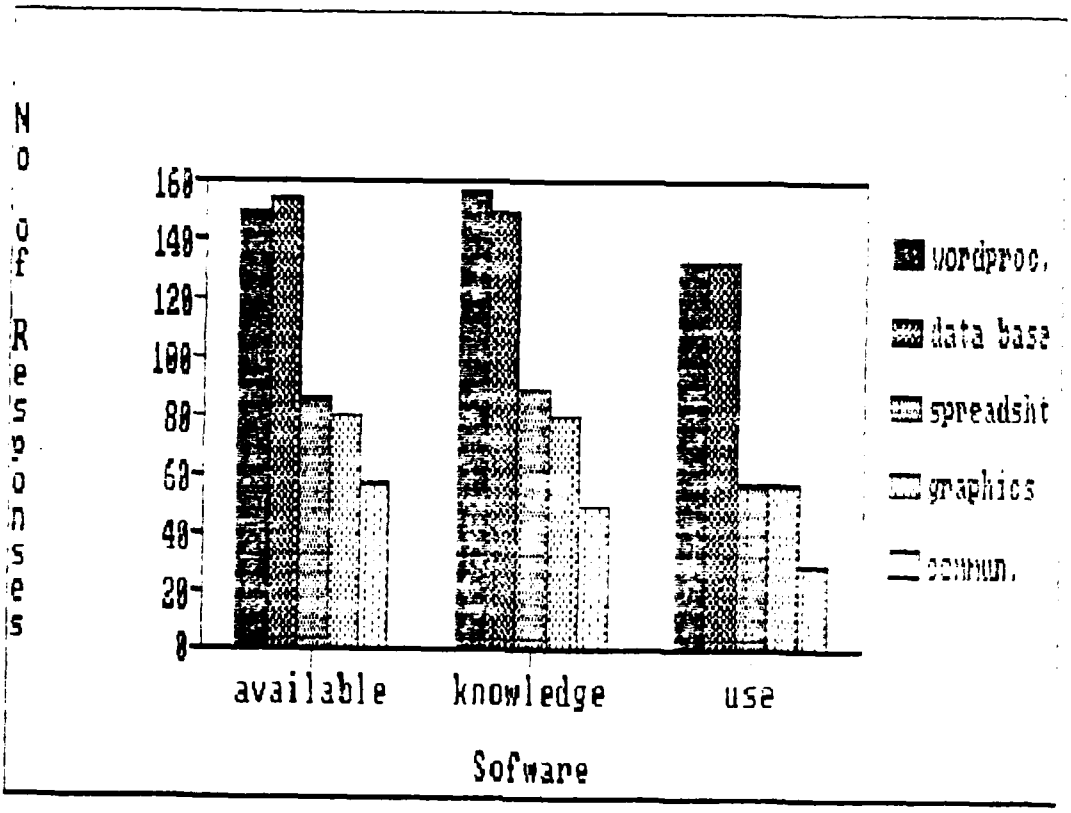

Figure 4. Software Comparisons

almost 73% of the respondents. Additional disk drives and modems are the next most frequently possessed items as indicated by over 50% and 38% of the respondents respectively.

Figure 4 is a compartive illustration of the responses to survey questions 5-7. This series of questions asked what types of software the end users had available within their units, what types of applications programs they are capable of operating, and what software they used in the performance of their jobs. It is important to note that only the types of software that were common to each of the

three questions are represented in this figure for comparitive analysis.

For virtually every type of software application program, the number of end users that have program availability or "know how", far exceeds the number of end users that use the individual programs in the performance of their jobs. The responses strongly suggest that the most widely known, used, and most available software applications are wordprocessing and data base programs.

Table 4.3 reflects the responses to survey question 26 which asked the end users to list all the sources of information they have consulted for assistance concerning microcomputer software. The responses received to this question are similar to those reflected in the study conducted by Lee concerning end user sources of support (15:320-321). Both studies indicate that the most frequently consulted source of information was colleagues or other end users. While Lee's study reflected almost 90% of the end users consulting other colleagues, the respondents to this research project indicated a rate slightly over 60%. The largest disparity between the two surveys was found in the consultation of vendors. Almost 50% of Lee's respondents indicated that they sought the support of vendors for software assistance, while only 5% of this research project indicated that vendors were consulted.

Similarly to the responses generated by survey question 22 which referenced microcomputer user group availability

Table 4.3

Frequency Table for Survey Question 27

Response	Frequency	Percentage of Respondents
Other Users	133	62.7%
Base IS Personnel	53	25.0%
Vendors	11	5.2%
Friends/Relatives	45	21.2%
Users Groups	10	4.7%
Journals	23	10.9%
Manuals/Documents	113	53.3%
Other	33	15.6%

and participation, less than 5% of those surveyed indicated that they consulted user groups for assistance. Of the respondents who listed what other sources of assistance they sought, the greatest percentage indicated that they had frequently consulted Air Force Systems personnel at Gunter AFB, Alabama.

Investigative question 5: The fifth investigative question was posed primarily for the purpose of identifying limiting factors that might significantly restrict or discourage end user participation in the area of software development. In Chapter II, five major problems of end user computing were identified which may be potential deterrents to software development efforts. The problems that were identified were: (1) training, (2) lack of time, (3) user

assistance, (4) standardization of software/equipment, and (5) lack of top level management direction.

As indicated in Chapter II, Tor Guiares and Vasudevan Ramanjam implied that the training end users receive is normally limited in scope, and the nature was basically technical. Furthermore, the authors stressed that many of those in the end user environment received very little, or no, formal training (10:182). This research effort had similar findings in these areas. The information received from the Keesler Technical Training Center presented in Chapter II, indicated that the nature of most of the training offered was basically to impart knowledge about the fundamental operation of software application programs. The training doesn't include instructing or assisting end users on how to incorporate the software technology into their specific operational disciplines. Additionally, as discovered by survey questions 8 and 9, only a small percentage of the respondents indicated that they had received formal training from their unit or from other Air Force sources (17% and 27% respectively).

The second potential limiting factor identified in Chapter II was that the end users may have little time during the normal workday to spend on developing individual software programs. As explained in Chapter II, an end user may very often be assigned to primary responsibilities other than those that require information systems. In a transportation organization, this is most often the case.

Information systems have been acquired to assist transportation agencies in the performance of their day-to-day operations. The individuals who are assigned the responsibility of operating the information systems are expected to do so in conjunction with their normal operations (23:381-396). Additional time required to experiment with software develoment is most often done at the expense of the individual sacrificing their personal time and effort.

The third problem associated with end user participation in software development was a lack of user assistance. For the most part, end user transporters must rely on resources other than their own personal knowledge, to solve problems or answer questions associated with microcomputer operations and software development. Table 4.3, introduced earlier in this chapter, summarized the responses to survey question 26 which asked end users to list all sources of assistance they consulted. According to Lee, it is not surprising that the most frequently consulted source of assistance is other end users. In his article about personal computer usage Lee concluded that: "Colleagues at work are the people who can best understand each other's needs. They speak the same language" (15:324).

The fourth potentially limiting factor identified by experts is a lack of standardized software and equipment within the end user environment. In the article "User Developed Software for Microcomputers", Captain James Van

Scotter stressed that the absence of an established hardware standard "invites a proliferation of different computer architectures and operating systems which can complicate support tremendously and result in signifcant interfacing problems" (31:22). Survey question 1, which was designed to examine this area, asked the respondents to identify what type of microcomputer(s) they had assigned to their individual section. The responses to this question revealed that an overwhelming 93% of the end users possessed Zenith microcomputers (primarily Z-248's and Z-100's) indicating that the lack of standardized hardware is not a problem in the Air Force transportation environment.

Another problem identified by Captain Van Scotter involves microcomputer software as opposed to hardware. He stressed that unless there was some form of centralized authority, management, or control of end user software development, the potential for duplication of effort and standardization would be a major problem. Survey question 15 asked the end user programmers to briefly describe what task their individually developed programs were used to perform. A summary of the responses to survey question 15, listed in Appendix B, reveals that there have been numerous programs developed by individual end users that are designed to perform the same basic tasks. The most frequently developed programs identified were in the administrative and fleet management areas. Of course these programs may use different software applications or require even different

hardware, but a strong point can be made for Captain Van Scotter's assumption that there is a redundancy of effort.

The fifth, and final potentially limiting factor identified by experts is a lack of top management direction. By reviewing the four previous problems identified, it becomes very apparent that the lack of managerial direction is at the heart of the problem. However, this problem is not unique to the Air Force or the transportation end user environment. Included in Chapter II was a complete analysis of some notably recognized approaches to managing end user computing, each with a description of potential benefits and/or detriments. Also included in that chapter was a brief description of some of the Air Force's current efforts towards providing a stronger framework in which the end users can operate. Hopefully, the discussion and analyis conducted in Chapter II, and the conclusions offered by this study will add to the current initiatives undertaken by the Air Force transportation officials.

Like the factors listed above associated with limiting or preventing the end user from participating in software development, there are similar barriers to end user software developers which preclude them from submitting their programs to the Air Force for possible standard- ization or sharing them with other end users. Survey questions 16-20, and 23-25 are all directly or indirectly related to this subject.

Of the 126 end users who indicated that they had

developed some form of program for a specific application, only ten stated that they had submitted one or more programs to the Air Force for possible standardization. Only 22 of this number indicated that they knew how to submit their programs for possible standardization, and only nine respondents said that they were familiar with the Small Compter Applications for Logistics and Engineering (SCALE) program. Contained in Appendix C is a summary of the responses to survey question 20 which asked the end users to briefly explain why they hadn't submitted their programs for possible standardization.

In response to survey question 16 which asked the end users if they had shared their self-developed programs with other users, over half of them indicated that they had shared their programs with others within their unit. The percentage of respondents that had shared their programs with end users at other units on the same base and other units at other bases was 23% and 31% respectively. One reason for the higher percentage of exchange of software for units at other bases may be because there is normally only one transportation organization at each base and there may not be a demand for the application elsewhere on the same installation.

Less than half of the total number of respondents (94) indicated that they had used software developed by other end users. And when asked to rate the end user programs, only 65% of those responding indicated that the programs were

Table 4.4

Frequency Table for Survey Question 12

Response	Frequency	Percentage of Respondents
None	86	40.8%
Less than 1 month	6	2.8%
1 to 3 months	13	6.2%
3 to 6 months	11	5.2%
6 months to 1 year	31	14.7%
1 to 2 years	16	7.6%
More than 2 years	48	22.8%

excellent or very good. However, when asked if they would be interested in obtaining copies of user developed software for particular applications, almost 95% of the total respondents replied positively.

Investigative question 6: The final investigative question for this research study sought to relate prior computer experience or computer knowledge to end users participation in software development. Survey questions 12, 13, and 27 were designed to assist in investigating this issue. Table 4.4 is summary of the responses to survey question 12 which asked the end users to indicate how much computer experience they had prior to their current responsibilities. This information reveals that more than half of the respondents had less than 6 months of computer experience or no computer experience at all. Only 22.8% had more than two years experience with other computer systems.

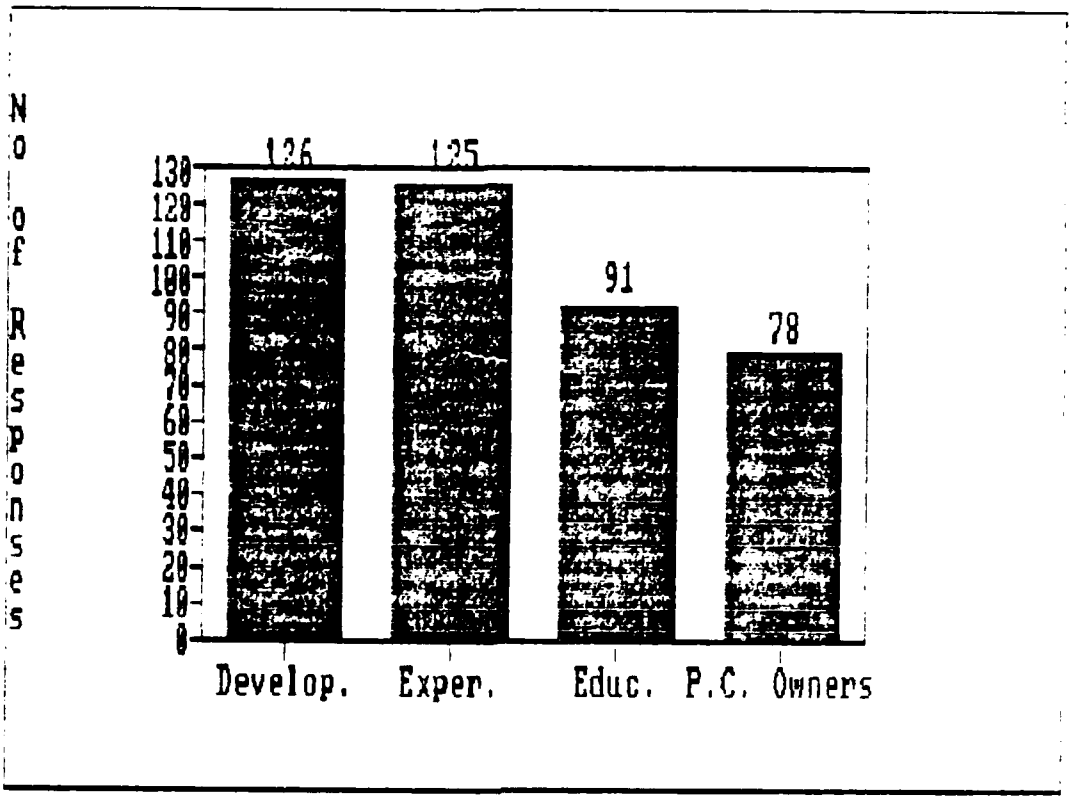

Figure 5. End User Computing Comparisons

When asked to indicate the highest level computer course that they had ever taken, 57% of the respondents stated that they had never taken a computer course. The percentage of end users that had taken one college level course was 17%, as was the percentage of individuals who had taken more than one college course. Figure 4 is a graphical comparison of the number of end users who actively participate in software development, the number who have taken at least one high school level computer course, the number who have at least one month computer experience, and the number of respondents who indicated that they are microcomputer owners.

Summary

This chapter presented the results and findings of the research survey in regards to the investigative questions posed in Chapter I. Statistical tests were conducted to examine the significance of survey findings in relationship to the end user transportation population. The final Chapter in this study will present the conclusions derived from the research effort and provides recommendations for further studies.

V. Conclusions and Recommendations

Introduction

The purpose of this research project was to study the current operations and attitudes of the transportation end user population for the purposes of identifying potential limiting factors in the area of software development. Further this study was designed to investigate current private industry trends in the area of end user management.

Chapter IV presented a detailed account of the results and findings of the data collection process. This section addresses the conclusions reached by this research study and discusses some recommended areas for further study on this subject.

Management of Transportation End Users

Chapter II outlined some current trends in the area of end user computing management, each with its potential benefits and limitations. Although these management techniques differed in design, the level and degree of control, and type of assistance offered to end users, they all stressed the same underlying principle. That is, end users are viable assets to any organization and should be looked to as a supplemental source of software development. Additionally, end users must be effectively managed and provided with sufficient guidance to ensure a proper balance between personal initatives and adherence to organizational goals. The results of this research study have been the

identification of three major areas of concern in which the Air Force should continue to focus its attention: (1) upper level management involvement in transportation end user policies, (2) training, and (3) end user initiatives.

Upper Level Management. In Chapter II one of the major problems of end user computing was identified as being a lack of top level management direction, the result of which can be a rapid and uncontrolled growth in the use of microcomputers. The Nolan Stage model explained that this end user enthusiasm and creativity invariably leads to the development of end user software application programs and is typical of the expansion stage (9:80-83). However, this research study has introduced evidence which suggests that the transportation community is well into Nolan's formalization stage of growth. The development of the Transportation Systems Integration Panal (TSIP) and subsequent initiatives to curb the uncontrolled growth of end user computing while providing a centralized component for charting future directions, are typical of the formalization stage described by the Nolan.

Chapter II also introduced some current approaches to managing end user computing that are being used by private industry. Current Air Force initiatives in end user computing strongly reflect certain major characteristics of two of these approaches: the Managed Free approach and the Organized approach. The Managed Free approach, which suggests that a central authority at a high managerial level

develop policies to limit and identify computing initiatives, is very similar in nature to what has been identified as one goal of the TSIP. This approach is further typified by a stated end user strategy that provides the organizational direction and key elements of implementation to personnel (8:33). The Organized approach to managing end user computing focuses on providing a common pool of technicians and experts to assist the end users in their computing efforts (16:340). Once again, this idea is clearly reflected in the proposed charter of the TSIP as presented in Appendix E.

This research suggests that the Air Force further investigate the basic principles associated with these two approaches to managing end user computing and establish an end user policy Air Force wide. Because of the very nature of the Air Force environment, a combination of these two approaches would probably be more desirable than one or the other by itself for purposes of control and coordination.

Training. One of the major findings of this study was that although the Air Force offers standardized training programs for microcomputer users, only a small number of transportation end users have attended any training programs. Additionally, the evidence presented in this study suggested that the type and nature of the training conducted is not always condusive to helping end users to help themselves. The training does not provide end users

with the tools and/or information required for documenting or troubleshooting their personal software efforts.

Because of the diversity of career fields in the transportation environment, the implementation of computer education into individual technical school programs is not feasible for the enlisted workforce. However, each transportation organization must attempt to seek out and identify resident computer experts and, with the assistance of the TSIP and local Information Systems office, establish a computer training program for end users and potential computer operators. Additionally, bases requiring training from the Small Computer Technical Training Branch located at Keesler AFB, should pool their computer resources to ensure that a sufficient number of computers and personnel are available for training.

End User Initiatives. As stated above, the first thing individual transportation agencies should do is to identify resident computer experts within the organization. Individuals who possess a high level of talent and interest in the area of computer operations and software development can greatly enhance a unit's ability to establish a strong computer training program. Once identified, these individuals should be afforded every opportunity available to get the required information, education, and materials (within reason) they need to support the unit's objectives. Further, they should be immediately instructed to coordinate their efforts with the TSIP or other appropriate agencies

for guidance and instruction. Additionally, units should urge end users to become involved with local user group activities. If the base does not sponsor a users group, end users must spur action to get one established. This study has presented strong evidence that suggest that other end users may be the best source of information for solving software related problems.

Another initiative which should be approached with caution is providing incentives and rewards to end users for their computing efforts. Although these are probably the most effective tools that can be used to motivate workers, they are often forgotten. Resident computer experts should be encouraged to take the lead in computer implementation and software development. If used effectively, incentives and rewards can lead to greater computer use and increase productivity while decreasing the resistance to use (23:393)

Recommendations for Further Research

The opportunities for further research in the area of end user computing and software development are numerous. This section suggests some areas which are related to this effort, but should not be considered an all inclusive list.

1. This survey effort was limited to transportation agencies only in the CONUS. Expanding the survey to include the entire Air Force transportation population may be beneficial to investigate Air Force wide trends.

2. By reaccomplishing the survey to allow for responses that provide ordinal or nominal data, a

correlation analysis could be calculated to examine the degree of significance or influence that prior computer training or experience has on end user software development in the transportation environment. This information might provide stronger evidence as to the importance of establishing a more effective training program for end users.

3. The evidence presented in this study strongly suggest that there is a high level of redundancy of effort in the area of software development. Further studies into the feasibility, cost, and requirements associated with establishing a centralized bulletin board network should be conducted.

4. As indicated by this study, current training programs for end users don't include documentating or troubleshooting for software programs. Additional studies in this area should be conducted to investigate what efforts, if any, are being made to correct this problem.

Summary

Increased emphasis is being given to the area of end user computing as evidenced by the numerous studies which have recently been conducted and current Air Force initiatives.

It is apparent that the transportation community can learn from the experience of others in the implementation of computer technology within the transportation environment. However, there are equally important lessons to learn in the

area of managing end users. In their article concerning the implementation of computer technology into transportation agencies, Pagano and Verdin concluded:

> The transportation organization must provide time for learning, opportunity for user involvement, incentives to use the system, and rewards to supervisors for encouraging use. When these managerial techniques are used effectively, microcomputer technology,..., can have a major effect in increasing productivity and efficiency in transportation [23:396].

With effective management and direction, end users will continue to be a major asset to the transportation environment and the Air Force as a whole.

Appendix A

Transportation Computer Survey

1. Type of microcomputer(s) assigned to your section:

a. ZENITH
b. IBM
c. SPERRY
d. KAYPRO
e. OTHER

2. Approximate time your section has possessed its microcomputer:

a. 1 to 6 months
b. 6 months to 1 year
c. 1 to 2 years
d. More than 2 years

3. Number of months you have used the system:

a. 1 to 6 months
b. 6 months to 1 year
c. 1 to 2 years
d. More than 2 years

4. What type of peripheral equipment does your section have for your microcomputer system?

a. DAISEY-WHEEL PRINTER
b. DOT-MATRIX PRINTER
c. GRAPHIC PLOTTER
d. MODEM
e. DISK DRIVE
f. OTHER

5. What types of software packages does our section have available for use with your microcomputer system?

a. DATA BASE PROGRAM
b. SPREADSHEET
c. WORDPROCESSOR
d. GRAPHICS
e. COMMUNICATIONS
f. OTHER

6. Which of the following types of software packages do you know how to use?

a. WORDPROCESSING PROGRAMS
b. DATA BASE PROGRAMS
c. SPREADSHEET PROGRAMS
d. DISK MAINTENANCE UTILITY
e. COMMUNICATIONS PROGRAMS
f. GRAPHICS PROGRAMS

7. Which of the available software packages do you use in support of your job?

a. SPREADSHEET APPLICATIONS
b. DATA BASE APPLICATIONS
c. STANDARDIZED AIR FORCE PROGRAMS
d. WORDPROCESSING PROGRAMS
e. GRAPHICS
f. COMMUNICATIONS
g. OTHER

8. Does your squadron offer a training program for microcomputer users to learn how to use the available software packages?

a. YES
b. NO

9. Have you attended any Air Force sponsored microcomputer training programs of workshops other than those offered in your squadron?

a. YES
b. NO

10. Does your organization offer a training program for new system users?

a. YES
b. NO

11. Does your organization have a published set of Operational Instructions (O.I.s) for the use of the micro-computer system?

a. YES
b. NO

12. How many months of computer experience did you have prior to assuming your present position?

a. NOT APPLICABLE NO PREVIOUS COMPUTER EXPERIENCE
b. LESS THAN 1 MONTH
c. 1 TO 3 MONTHS
d. 3 TO 6 MONTHS
e. 6 MONTHS TO 1 YEAR
f. 1 TO 2 YEARS
g. MORE THAN 2 YEARS

13. Circle the highest level computer programming course you have taken:

a. ONE HIGH SCHOOL LEVEL COURSE
b. MORE THAN ONE HIGH SCHOOL LEVEL COURSE
c. ONE COLLEGE LEVEL COURSE
d. MORE THAN ONE COLLEGE LEVEL COURSE
e. A GRADUATE LEVEL COURSE
f. NONE

14. Which of the following types of software have you adapted for a particular application? (e.g. Using a wordprocessing program to create a "FORMAT" for OERs/APRs such that appropriate information can be inserted in the appropriate "blanks")

a. NONE
b. WORDPROCESSING
c. DATA BASE MANAGEMENT
d. SPREADSHEET
e. GRAPHICS
f. COMMUNICATIONS
g. DISK MAINTENANCE/UTILITIES
h. OTHER

15. What particular application(s) is the adapted software package used for?

16. Have you shared your application program(s) with other users?

Yes,
a. WITHIN THE SQUADRON
b. WITH OTHTER SQUADRONS AT MY BASE
c. WITH SQUADRONS AT OTHER BASES

No,
d. BUT I WOULD BE WILLING TO SHARE IT (THEM)
e. AND I WOULD NOT BE WILLING TO SHARE IT (THEM)

17. How many of your application programs have you submitted to the Air Force for possible standardization?

a. Ø
b. 1
c. 2
d. 3
e. 4
f. MORE THAN 4

18. Do you know how to submit self-developed software for possible standardization?

a. YES
b. NO

19. Are you familiar with the Small Compuer Appliations for Logistics and Engineering (SCALE) Program?

a. YES
b. NO

2Ø. Please briefly explain why you haven't submitted your programs for possible standardization.

21. How helpful is the microcomputer in the performance of your job?

a. EXTREMELY HELPFUL
b. VERY HELPFUL
c. HELPFUL
d. SOMEWHAT HELPFUL
e. NOT AT ALL HELPFUL

22. Does your base sponsor a microcomputer users group for your particular compuer system?

a. YES, AND I ACTIVELY PARTICIPATE IN THE GROUP
b. YES, BUT I DO NOT ACTIVELY PARTICIPATE IN THE GROUP
c. NO
d. DON'T KNOW

23. Have you used any user developed software programs other than your own?

a. YES
b. NO
c. DON'T KNOW

24. If yes, how would you rate them?

a. EXCELLENT
b. VERY GOOD
c. GOOD
d. FAIR
e. POOR

25. Would you be interested in obtaining copies of software which users have adapated for specific job-related applications?

a. YES
b. NO

26. Please identify sources of information you have found helpful for answering your software problems:

a. OTHER COMPUTER USERS IN YOUR ORGANIZATION
b. BASE INFORMATION SYSTEMS (IS) PERSONNEL
c. VENDORS
d. FRIENDS AND RELATIVES
e. COMPUTER USERS GROUPS
f. JOURNALS
g. MANUALS AND DOCUMENTS
h. OTHER

27. Do you own a personal computer?

a. YES
b. NO

Appendix B

Summary of responses to survey question 15

What particular application(s) is your adapted software package used for?

Administrative (57)
- Files management
- Generate recurring reports
- Messages
- Letters of Appointment
- Develop briefing slides/charts
- Develop blank form shells
- Generate sponsor letters
- Generate/update recall rosters
- Generate meeting agendas/minutes
- Unit budget management/analysis
- Track unit work orders
- Automated submission of T.O. requests

Personnel Appraisals/Awards (27)
- Airman Performance Reports (APRs)
- Officer Effectiveness Reports (OERs)
- Civilian Personnel Reports (JPAS)

Personnel Management (6)
- Personnel updates and listings
- Workload comparisons scheduling

Fleet Management (34)
- Vehicle Due-In listings
- Quaterly Semi-Annual statistics
- Shuttle bus scheduling and routing
- Parking plans
- Off-base fuel transactions
- Vehicle status reports
- Vehicle analysis
- Vehicle autorization lists
- Automated R&R s
- Automated Form 1's (vehicle rentals)

Drivers Evaluation (1)

Surface Freight Processing (1)
- Manifesting
- Cargo Processing
- Automated GBL generation logs
- Automated DD Form 1164 generation
- Carrier listings
- Tonnage distribution
- In-bound personal property tracking
- Non-Temp storage tracking

Air Transport (3)
- Air Freight manifesting
- Freight flow control
- Space available passenger rosters

Vehicle Maintenance (11)
- Call data for Vehicle Maintenance
- Scheduled Maintenance generation
- VDP/VDM information
- VIMS

Material Control (21)
- Tool listings
- Tool box inventories
- Bench Stock inventories
- Material Control inventories

Mobility (16)
- Mobility augmentee training
- Mobility personnel management
- Lesson plan generation
- Automated Transportation Schedule of Events
- OPLAN Base Support Plans management

Unit Training (16)
- OJT requirements updates
- Ancillary training
- Disaster Preparedness requirements scheduling

Appendix C

Summary of responses to survey question 20

Why haven't you submitted your self-developed programs for possible standardization?

Did not know how. (24)

Program not ready yet. (17)

Just a simple program. (8)

Programs only apply to in-house operations. (4)

I don't have sufficient training. (4)

Being accomplished at another base. (3)

Just an interim program until the AF puts theirs on-line (3)

Never thought about it (2)

HQ SAC says what I'm doing is already under consideration.

Similar programs already out. Not very user friendly.

I figured if I developed a program, someone else did too.

Most are done with the cooperation of someone else.

No good for large scale application.

Submitted a copy to HQ SAC for info. Did not know how otherwise.

Don't want to at this time.

Basically it would be too time consuming, and someone probably has a better method.

Too small, but we will be submitting two soon.

Sounds too involved and complicated.

Always considered it as part of my job. Not time spent to make it a standardized application.

Just starting to develop my own programs.

We don't have a computer expert and we are well behind other bases in our software development efforts.

Appendix D

Summary of Survey Responses

1. Types of micro's assigned:

Zenith	200
IBM	1
Sperry	10
Kaypro	0
Other	5

2. Section has possessed micro:

1-6 months	38
6 mos-1 yr	55
1-2 yrs	76
2 yrs or more	33

3. Used system:

1-6 months	53
6 mos-1 yr	60
1-2 yrs	64
2 yrs or more	17

4. Peripheral equipment:

Daisey Whl Prt	41
Dot-Matrix Prt	154
Graphic Plotter	19
Modem	81
Disk Drive	108
Other	27

5. Software available:

Data Base	154
Spreadsheet	87
Wordprocessor	150
Graphics	80
Communications	57
Other	50

6. Software knowledge:

Wordprocessing	157
Data Base	150
Spreadsheet	90
Disk MX/Utility	88
Communications	49
Graphics	80

7. Software being used:

Spreadsheet	57
Data base	132
Stand. AF	104
Worprocessing	132
Graphics	29
Communications	26

8. Unit training program:

yes	33
no	167

9. Attended AF training:

yes	57
no	153

10. Training for new users:

yes	37
no	171

11. Unit O.I.s for micro:

yes	68
no	143

12. Computer experience:

None	86
< 1 month	6
1-3 months	13
3-6 months	11
6 mos - 1 yr	31
1 - 2 years	16
2 yrs or more	48

13. Computer education:

One high school	4
> One high school	6
One college	35
> One college	36
A graduate course	9
None	121

14. Software developed using:

None	87
Wordprocessing	95
Data Base	75
Spreadsheet	43
Graphics	26
Communications	6
Disk MX/Utility	22
Other	11

16. Shared programs:

Yes, in unit	68
Yes, on base	29
Yes, off base	39
No, but willing	37
No, not willing	6

17. Number programs submitted:

Ø	116
1	5
2	3
3	Ø
4	1
> 4	1

18. Know how to submit for standardization:

yes	22
no	1Ø3

19. SCALE familiarization:

yes	9
no	115

21. Microcomputer helpfulness:

Extremely helpful	128
Very helpful	43
Helpful	17
Somewhat helpful	1Ø
Not helpful at all	1

22. Base Users Group:

Yes, partic.	11
Yes, nonpartic.	35
No	55
Don't know	91

23. Use end user software:

Yes	94
No	86
Don't know	11

24. Rate end user software:

Excellent	33
Very Good	41
Good	31
Fair	5
Poor	3

25. More end user programs:

yes	2Ø1
no	8

26. Sources of assistance:

Other users	133
Base IS personnel	53
Vendors	11
Friends/Relatives	45
Users groups	1Ø
Journals	23
Manuals/Docu.	113
Other	33

27. P.C. ownership:

yes	78
no	13Ø

Appendix E

Proposed Transportation Systems Integration Panel (TSIP) Charter

1. PURPOSE: The Air Force Transportation System Integration Panel (TSIP) will provide end users with the direction necessary to develop and refine non-standard, interim software computer programs for Air Force Transportation. Also, the the TSIP will ensure that standard computer systems under development will incorporate the needed functional interfaces and infra-structure to accomodate Base level to high command communications and reporting. In addition, the TSIP will study developing standard system architecture to ensure base-level and command-level computer needs will be met. Finally, the TSIP will serve as the avenue to carry out the proposals of the Transportation System Advisary Group (TSAG).

2. The Transportation Systems Integration Panel will accomplish this purpose by:

a. Identifying available training and documention (government, contracted, commercial, or in-house) to aid in system definition and development.

b. Assisting experienced users in solution strategies. Solution strategies involve the TSIP at either base level, MAJCOM, or HQ USAF, helping the user determine the best method and capabilities for solving a problem. DEFINITION: An experienced user for support of products is one who can perform basic functions competently and without assistance.

c. Assisting in expanding the use of technology and programs to meet the changing requirements of a growing end user community as well as the needs of the Directors of Transportation.

d. Assisting in increasing management awareness of the potential benefits to the Air Force and the end user with the use of computers.

e. Assisting the TSAG in establishing end user computer policies.

f. Assisting in maintaining a high level of user (MAJCOM and base-level) satisfaction.

g. Recommending software development to the Directors of Transportation (HQ USAF, MAJCOM), squadron commanders, and other transportation executives to establish proper reporting architecture.

h. Evaluating and publicizing end user developed software for worldwide dissemination.

i. Identifying training needs to the Transportation Training Advisory Group (TTAG) of standard and non-standard computer programs.

j. Identifying to Headquarters Air Force/LETX-TSC, individual Major Command recommendations to Air Force regulation changes for inclusion into the Transportation Base Information Analysis Database.

3. In accomplishing its mission, the TSIP will interact with:

a. HQ United States Air Force LET staff on all Management Information Systems (MIS) matters.

b. Standard System Center on all standard microcomputer and interfacing system initiatives as well as on any standard, inter/intra-command or agency microcomputer applications and initiatives.

c. Air Force Logistics Management Center LGT on non-standard microcomputer appliations and initiatives.

d. Transportation Systems Advisory Group.

4. ADMINISTRATION:

(1) The working panels will be composed of personnel with a detailed working knowledge of their respective functional areas. The purpose for these groups will be to address requirements for automation and prioritization of requirements, interfaces, and training (initial and recurring). Panels will be chaired by the corresponding HQ Staff division chief or his designated representative.

(2) Working panel membership will be as designated by the Executive Council based upon Major Air Command [illegible] interest and desires to participate in resolution of specific problems to be addressed by the working panels.

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFIT/GLM/LSMA/87S-12	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION School of Systems and Logistics 6b. OFFICE SYMBOL (If applicable) AFIT/LSM	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Air Force Institute of Technology Wright- Patterson AFB OH 45433-6583	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification)

See Box 19

12. PERSONAL AUTHOR(S)

Keith A. Caver, B.S., 1Lt, USAF

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
MS Thesis	FROM _____ TO _____	1987 September	86

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	
12	05		Computer programming Computer operators Transportation Computer personnel

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Title: END USER SOFTWARE DEVELOPMENT FOR TRANSPORTATION APPLICATIONS

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Approved for public release: IAW AFR 190 [illegible]
24 Sept 87
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20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Kent N. Gourdin, Major, USAF	22b. TELEPHONE (Include Area Code) (513) 255-4149 22c. OFFICE SYMBOL AFIT/LSMA

DD Form 1473, JUN 86 *Previous editions are obsolete.*

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

Block 19

The purpose of this study was to conduct a comprehensive analysis of the current operations and attitudes of end users in the Air Force transportation community in an attempt to identify potential problems in microcomputer operations and software development. Further, this study reviewed the current trends within private industry in the area of end user computing to explore how end users might be managed more effectively.

The study uses survey responses from a probability sample of end users assigned to CONUS transportation activities to measure current transportation end user opinion. Additionally, the survey responses measure end user involvement in software development.

This study identified three major areas of concern that the Air Force should concentrate its attention on to increase end user productivity and participation: (1) upper level management involvement in establishing transportation end user policies, (2) training, and (3) end user initiatives.

Analysis of the surveys found that the number of end users who are actively involved in software development is significantly representative of the transportation end user environment.

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